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THE FUTURE OF AGRICULTURAL SCIENCE IN THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

IT is certainly within the recollection of the youngest member of Section O that the attachment of the designation *Agricultural* at once removed the matter under discussion from the scientific field. Agricultural botany, agricultural physics, agricultural chemistry, and the other agriculturals were simply the reflections of the glories of the pure sciences into the dark, unfathomed caves of everyday living. No real botanist would study the corn plant. No real chemist would waste his time on its chemical composition. The physics of the soil was certainly beneath the physicist. Such lights in the darkness as Darwin, Liebig and Pasteur (whose great work was done with domesticated plants and animals, soils and industries agricultural in the broad sense) failed to sensitize the blind spots in the minds of the pure scientists of yesterday. To-day this situation no longer exists, not so much because of any change in the sciences themselves, but more because of the sensitization of the blind spots in the minds of those who devote themselves to scientific study.

This change has come about largely as the result of the work of the agricultural experiment stations. It is true that in the beginning much was done by workers in the stations in the name of science that was not scientific, but that has always been true, even more in the history of so-called pure science than in this period of the beginning of agricultural science. It is generally true to-day. In the beginnings of agricultural science,

[1] Abstract of the address of the vice-president and chairman of Section O, Agriculture, American Association for the Advancement of Science, Chicago, 1920.

speaking generally, the workers of necessity came from the so-called pure science field. While they doubtless lost caste for a time, many of them have lived to see the old opposition die. The best universities in the land are now proud to call these men from the agricultural experiment stations to their highest research positions.

The worker in the land grant college, the experiment station or the National Department of Agriculture, as in other fields, is now accepted on his merits as a research worker. Research in the field of agriculture has, as in the days of Darwin, been so fruitful in results of scientific as well as economic value that it is receiving the attention of such institutions as Harvard, Yale, Columbia, Johns Hopkins and Chicago, as well as of the great state universities, and most recently by the Rockefeller Foundation for Medical Research in its laboratories for animal diseases under the direction of Dr. Theobald Smith, formerly in the Bureau of Animal Industry, of the U. S. Department of Agriculture, and later in the Bussey Institution of Harvard University. This Foundation also contemplates a similar laboratory for phytopathological research.

The latest development in this field is the organization of the Division of Biology and Agriculture of the National Research Council, an agency established by the National Academy of Sciences at the request of the President of the United States, to organize and conduct research in every field necessary during the world war. After the close of the war the President requested that the Council be reorganized for the promotion of research of value to the nation and placed on a permanent basis. This was carried out in a comprehensive way, supplementing existing agencies, governmental and private, without supplanting them; in fact, the National Research Council is now a clearing house of research agencies of the United States, also having relations with similar organizations abroad through an international association. It supplements the work of the American Association for the Advancement of Science, and through stimulating research in general it will, without doubt, increase the interest of scientific workers in this association, which is the greatest organized scientific forum of the United States. Every live scientific worker in America should join this association through the sections in which he is especially interested. Section O should be the largest and livest Section of the Association. We draw from all sciences and are interested in all, including those usually designated as social and economic. We may be members also of special affiliated societies, like the Botanical Society of America, the Society for the Promotion of Agricultural Science, etc., but that is all the greater reason why we should be members of Section O—the agricultural focus of this association.

It has been proposed to merge the famous old Society for the Promotion of Agricultural Science with Section O. I believe that this is a wise move. Possibly the same idea could be carried out with reference to some other societies in relation to other Sections. We need but two types of society organization based on subject matter—one small, select, highly specialized group and one generalized group. There are now too many organizations covering practically the same field. Time and money are not available to keep in touch with all. Let us carefully study the problem and consolidate wherever it can be done to advantage. All of the great research organizations ought to be affiliated with the American Association for the Advancement of Science and hold their meetings at the same place in such way as not to conflict with each other. This has been accomplished in part. It should now be completed.

While much has been accomplished in agricultural investigation in the past we are just entering what may rightly be termed the scientific phase of agricultural development. Research in this field must be greatly intensified. The mere mention of some of the fields such as genetics, plant and animal nutrition, plant and animal disease, disease resistance and immunity, and soil biology will recall to your minds at once the fact that we are just

at the beginning. If we are to feed and clothe the increasing population of the world and still retain some time for culture and recreation we shall need to conduct scientific research in all fields to an extent hitherto unheard of. This is especially true in the fields represented by this section. Unless we succeed in furnishing food and clothing nothing else avails. Except for temporary displacements, due to faulty distribution, population increase has been more rapid than food production. The time is at hand when we should have scientific information regarding disease control, genetics, maintenance of fertility and cultural methods which we do not now possess. It may take years of patient study to get it. We must educate the public to understand the need and provide for it. It is a part of the duty of this association to take part in this educational work. It is the special duty of this section in regard to agricultural science. Let us be a federation of inspiring spirits as well as active workers for its promotion.

A. F. WOODS

UNIVERSITY OF MARYLAND

INVESTIGATION OF THE FLORA OF NORTHERN SOUTH AMERICA[1]

IN the summer of 1918, after consultation and correspondence by members of the staffs of the New York Botanical Garden, the United States National Museum and the Gray Herbarium of Harvard University, a cooperative investigation of the botany and plant products of northern South America was organized and has since been prosecuted. It is planned to include geographically the Guianas, Venezuela, Colombia, Ecuador, and the adjacent Caribbean islands Trinidad, Tobago, Margarita, Bonaire, Curaçao and Aruba.[2]

The reasons for the investigation are the deficiency of exact information relative to the vegetation of the region and the paucity of specimens of plants inhabiting it in museums and herbaria of the United States. By far the larger representation of the species is in European institutions. A great number of them have been collected only once, and records of habit and habitat are either altogether lacking or quite inadequate. Owing to the necessity of making comparisons of specimens with the types preserved in the European collections, much of the material which has hitherto found its way into American institutions has remained incompletely determined. While the published literature of the subject is large, it is widely scattered, and there are no complete lists of plants or descriptive floras of any part of the area under investigation; such monographs or lists of species of genera or of families as have been attempted by authors are incomplete and very many species have been erroneously identified. As to plant products, we are as yet uninformed in many cases as to the identity of the species of plants yielding them and whether or not the supply of such products can be increased by the cultivation of the species from which they are derived.

The investigation is making progress in remedying these conditions, through the study of series of specimens recently obtained in Dutch Guiana, British Guiana, Trinidad, Tobago, Venezuela, Curaçao, Colombia and Ecuador, collectively providing specimens representing several thousand species, and further field expeditions are being arranged. The collections when received, are divided among the three cooperating institutions, field agents being instructed to obtain three specimens of each plant collected whenever possible, and also to make record of habit, habitat and color of flowers and fruits and to make other notes which may be of importance. Specimens beyond three in number may be sent to other institutions or to specialists, and the cooperation of many experts has been obtained.

Preliminary studies of the collections already made prove that the investigation is very well worth while. Dr. Francis W. Pennell, of the New York Botanical Garden staff, expert in the Family Scrophulariaceæ, has detected and partly described some 70 species

[1] Read at the Princeton meeting of the National Academy of Sciences.

[2] See SCIENCE, 48: 156, 157, 1918.

new to Science from his own collections made in Colombia and in those made in Ecuador by Dr. J. N. Rose. These collections have yielded to Dr. B. L. Robinson, of the Gray Herbarium, expert in the genus *Eupatorium*, some 20 undescribed species, and to Dr. J. M. Greenman, of the Missouri Botanical Garden, expert in *Senecio*, about a dozen. Many grasses new to science were collected by Dr. A. S. Hitchcock, Agrostologist of the United States Department of Agriculture, in Venezuela, British Guiana, Trinidad and Tobago, and those obtained by other collectors have been classified by him. Much important information about the Cacti and some 10 new species were obtained by Dr. J. N. Rose, in Venezuela and in Ecuador. Dr. S. F. Blake, of the Bureau of Plant Industry, has done much work on the Carduaceæ.

Mr. W. R. Maxon, of the United States National Museum, is engaged in identifying the Ferns and Fern Allies, Mrs. Britton, at the New York Botanical Garden, is studying the Mosses, and Professor Alexander W. Evans, of Yale University, the Hepatics. Dr. W. A. Murrill and Dr. Fred. J. Seaver, of the New York Botanical Garden, and Dr. J. C. Arthur, at Purdue University, have partially identified the Fungi collected. Several other students are investigating smaller groups.

Much desultory work in identifying plants incidental in various families has been accomplished by Dr. J. N. Rose, by Dr. B. L. Robinson and by me. In order to make comparisons with types and authentically named specimens, I took this summer several hundred recently collected specimens of several families to the Royal Botanical Gardens at Kew, England, and compared them with the great collection preserved in the herbarium there; the wealth of undescribed species in the region under study is well illustrated by the fact that I was able to match only a small proportion of them.

In order to obtain a view of the vegetation and to increase the collections, I spent March and April in Trinidad, the part of the region perhaps the best known botanically, but even there I was able to add some fifty species to the known flora of that island, some of them new to science, through specimens collected by myself and members of my party and by studying the fine herbarium of the Botanical Garden at Port of Spain.

The field work has mostly to be done by collectors sent from the north, but we have highly valued cooperation from Mr. W. G. Freeman, Director of Agriculture of Trinidad and Tobago, and Mr. W. E. Broadway and others of his staff; Mr. Henri Pittier, Agricultural Expert of the Venezuelan government, is sending material from that republic; when Dr. Pennell was in Bogota, Colombia, he secured the cordial cooperation of the Christian brothers there, who are forming a Natural History Museum, and when Dr. Rose was in Ecuador he secured the interest of Mr. A. Pachano; we are also assured of cooperation through the governments of French Guiana, Dutch Guiana and British Guiana.

The investigation is also adding much to the knowledge of the natural geographic distribution of species, especially as regards those ranging into Panama and the West Indies.

It is becoming increasingly evident that we should obtain as much exact information as possible concerning the vegetation of tropical and subtropical America.

N. L. Britton

New York Botanical Garden

PRACTICAL PSYCHOLOGY[1]

It is not easy to find an adjective describing adequately the applied psychology of tomorrow. "Solvent psychology," even apart from the alliteration, makes a certain appeal, for it designates a science capable of meeting all obligations; but the word has implications of deductive solutions reminiscent of metaphysics, Christian Science, psychical research, psycho-analysis, and other mysteries. William James, our distinguished master, has given

[1] An address before the Section of Psychology at the Chicago meeting of the American Association for the Advancement of Science, December 29, 1920.

such currency to pragmatism in philosophy that the word might be carried over into psychology. The dictionary, however, defines "pragmatic" as "officious, occupied with trifles"; so perhaps the word should be reserved for philosophy. "Practical," of the same origin as pragmatic, also illustrates the tendency of the meanings of words to deteriorate that throws a curious light on human nature. For as those who can do things have come to be called cunning, crafty, scheming, artful and designing, so those who continue to do things are looked at somewhat askance; when a famous letter used the phrase "you and I are practical men," the reference was not understood to be to perseverance in good works. However, we must do the best we can with a language imposed upon us when we were helpless infants; in so far as practical psychology means psychology based on the facts of experience, applied to useful ends and earning the means for its support and advance, it defines the kind of psychology that I wish to advocate.

It is no longer necessary to argue that psychology is a science resting upon experiment and measurement, that it is primarily concerned with individual differences in behavior, that it can and should be applied to promote human welfare. Psychology is much more concerned with what people do than with what philosophers think they think. Yet I look back to a time when I was in a minority —almost a minority of one—in urging these things. We are perhaps now no less dogmatic than our former opponents; as they once told us that the things in which we were interested were not psychology, so we to-day are likely to excommunicate from our fellowship any who hold that psychology consists of introspections of philosophers that are universally true but have nothing more to do with conduct than theology has to do with the control of the Being whose attributes it describes.

But those of us who believe in applied psychology still have to face and solve the problem of applying psychology to secure the support and advancement of psychology, and this from the standpoint of practical psychology is equivalent to the support and advancement of psychologists; for we obviously are the *veræ causæ* of psychological research. Progress there certainly has been. We are no longer little sisters in the house of philosophy. We supply an eligible list for every vacant presidency of a university or endowed corporation. We are paid about the same salaries and have about as many students, summer courses, extension courses and correspondence courses as our colleagues. In innumerable faculty and committee meetings we share their polyphasia and their apraxia. We also are permitted to devote our leisure time to research.

Psychologists are in somewhat the same situation as students of other subjects; but there are several distinctions. Having recently arrived and belonging to the comparatively *nouveaux riches,* we are self-conscious beyond the average; and as we propose to concern ourselves with the control of conduct we can be professionally occupied with the conditions under which we work, while in this regard others are only amateurs. If we can select college freshmen and telephone girls, we should begin at home and be experts in selecting psychologists for the laboratory; if we can determine the conditions under which factory hands work to the best advantage, we should be able to learn how psychological research can be accomplished most effectively; if we can describe and direct the complicated behavior of infants and children, we should be able to understand and control the simpler and more naïve official reactions of university presidents and trustees.

It is further the case that professional psychologists are at the present time a group so small that they can cooperate in a way impossible for the hundred and fifty thousand physicians or engineers of the country. The members of the American Psychological Association number 393, and there are not so many competent American psychologists, for the association does not undertake to exercise a censorship over the standards of its members. All American psychologists can get together in a room and each can be personally ac-

quainted with all. There are probably as many psychologists in the United States as in the rest of the world. The responsibility of each of us is large.

Why should we not unite to take over the psychological work of the country and conduct it in the interest of psychology? The railway men and the coal miners propose to manage the railways and the mines; but these are difficult undertakings, owing to the vast number of men and the immense properties that are involved. At present corporations, trade unions and other associations of individuals and interests are more potent forces in the social order than congresses or legislatures. Being unfortunately interested in the cost of printing, I have some information on that subject. The working printers by efficiently organized unions have been able to increase their wages beyond those of professors. The employing printers have in turn organized a United Typothetæ do deal with the compositors and the pressmen and more especially with the publishers and the public, which latter they have done effectively by increasing costs more than 100 per cent. Now a publishers association has been organized and there is also a writers union. It is the poor ultimate consumers who must take what is handed to them, though they too are beginning to cooperate.

As teachers or salaried experts psychologists are employees, but very few scientific men are employed primarily to undertake research. There is no reason why college and university teachers should not unite, as public school teachers are now doing, to increase their salaries, to secure permanence of tenure or to improve the conditions under which they work. Perhaps the first step in this direction taken by a scientific society was a resolution proposed by me and passed at the meeting of the American Psychological Association in 1912 to the effect that it is inadvisable for members to give summer or extension courses at a lower rate than their regular salaries. The association has also joined with the American Philosophical Association in a protest against dismissing a member from a college on account of the doctrines that he taught, and just now it is defining the qualifications for psychological experts. The American Association of University Professors has been expressly organized to safeguard academic freedom and the rights of teachers in so far as that can be accomplished by committee reports.

But such halting steps carry us only a short way. In our psychological research work we are not as a rule employees, but capitalists to the extent of the ability that we have. It is almost the only capital that can be used in this way; its earnings represent an enormous usury that accrues not to the individual but to society. This should be its ultimate destination; but if the capital is not increased and used to the best advantage, then all suffer. Research in any science is worth manyfold its cost; if an organized democracy can learn this fact and act accordingly the problem is solved. In the meanwhile it is our business to see that we reserve for research part of what we earn and use it to increase our working capital, namely, the number of competent psychologists and their opportunities to advance psychology and to apply it in useful ways.

Research and practise in psychology are not essentially different from research and practise in other subjects, except in so far as the inventions of the psychologist are not protected by the patent office. Dr. F. G. Cottrell has devised an admirable benefaction—if benefactions are ever admirable—by presenting to a corporation valuable patents, the proceeds to be used for other researches. But in general men earn their livings by teaching or applying science and advance it only as a sport. An expert and popular surgeon can earn $50,000 a year by cutting out appendices, but if he should by prolonged research discover a cure for appendicitis, he would be paid only in the fiat currency of honorary degrees or the like and would lose his practise. A professor of psychology can with the utmost difficulty increase his salary by his published researches; he can do so readily by becoming one of the house carls of the president.

Apart from using research as a kind of lottery in which men may draw better uni-

versity positions and hold them without further effort, so long as they observe all the proprieties of their social caste, the rewards and opportunities for carrying on research as a profession are few. The government does something; but it has scarcely discovered psychology, and its methods seem devised for the suppression of originality. Several foundations, munificently endowed from the proceeds of monopoly and a protective tariff, are providing for excellent research work; we may hope that psychology will some day share the spoils in case they do not involve any explicit or implicit controls. The research laboratories of the industrial corporations are the most promising development of recent years. There are more of these than there are university laboratories of physics and chemistry, and they probably already surpass academic work in quantity and quality, not only in applied science, but also in science not obviously or immediately useful. In this direction the Scott Company has made a beginning auspicious for psychology.

But as a rule scientific men are employees with a tendency to belong to the class of domestic servants rather than to the artisans with well organized unions. For not only are our wages fixed by the favor of superior officials, but we are expected to exhibit the virtues of the domestic servant and to submit to similar regulations as to wash days, days off, liveries, sweethearts, respectful speech and the rest. This situation obtains wherever scientific men are employed—in the government service, in universities, in research foundations, in industrial laboratories—though these seem to represent a series of increasing salaries and decreasing restrictions.

It need not be considered here whether it is in the interest of science and of society for teachers or employed experts to form unions; but it may be remarked that a point in their favor is the fact that teachers are now being dismissed because they belong to them. My argument is that while as teachers, administrative officials and institutional experts we are employees, as psychologists we are capitalists to the extent of our ability, originality and energy. We should form associations to employ our brains in the most useful and profitable ways.

Lord Kelvin was a university professor, an electrical engineer and a mathematical physicist. As a teacher he received a modest salary, as an inventor and expert he made a large fortune, as a scientific man his reward was to be president of the Royal Society and to lose his good name as William Thomson. For the latter circumstance, however, his money and his lack of an heir were largely responsible; Faraday did not become even a Sir. Kelvin was paid inversely as the value of his diverse services; but he could be comfortable as a teacher and command time, assistance and equipment for research through the means that he earned as an engineer. It is also the case that, if his teaching had been confined to research students, the three lines of his work would have been reciprocally helpful.

None of us is a Kelvin, but collectively we do work more important in teaching, in the applications of science and in research. Many individuals try to do the three things, but we do not have either the genius or the opportunity that Kelvin had. Correspondence courses, elementary text-books, pot-boilers, even the administration of routine tests, are not conducive to research, and may result in a sweat-shop system by which regular salaries are reduced below the living wage. But it would be posible for us to unite to use our resources for the common benefit of society, of psychology and of ourselves. The wage fund for teachers and experts is not fixed by unrepealable economic laws, but could be doubled by proper efforts. If one tenth of the economic by-products of research could be reserved for the workers, and a second tenth for the support of further research, if one tenth of the economic value of the applications of psychology could be paid to the psychologist who does the work and a second tenth be devoted to new investigations, then psychological research would be supported to an extent hitherto undreamed of in the his-

tory of science, and still society would receive eight tenths of our services as a free gift.

The tests of individual differences devised by a few psychologists in the course of the past thirty years have been dramatically exploited by the tragedy of war. These measurements of general intelligence and special aptitudes are interwoven with the whole fabric of the mantle of science, but the direct work of consequence involved in their development was done by a score of us in the intervals between the hours of our employment. When a committee was formed to adjust these tests to the needs of the army not even our traveling expenses were paid. An officer high in the army has estimated at a billion dollars the value of the gift gladly made to the nation; it would indeed have been so much if the war had been long continued. At a cost of about fifty cents each, tests were made on nearly two million recruits, and the value of each for purposes of promotion, elimination and selection appears to have been somewhere between ten and one hundred dollars. The economic value of such tests for school systems, for the government service, for industries, in all cases where individuals are selected for work, for promotion or for special tasks, is equally great.

By psychological tests made in an hour and at a nominal cost, we may tell better to what classes children should be assigned in school than can the teachers who have taught them for months. We may tell better from such tests whether a boy is fit for college or for a scholarship there than from a mnemonic examination in preparation for which years of his life have in large part been misspent. We may select recruits for promotion or for special assignments in the army more accurately than can their superior officers. We may determine the fitness of clerks, telephone girls and many other groups better than can their employers. With increased knowledge such as can be gained from further research, we may be able to double the productivity of labor by selecting individuals for the work for which they are best fit, all the way from the moron to the president of the nation. That would mean an annual increase in wealth of seventy billion dollars a year for this country, of five times as much for the world.

The productivity of labor can probably again be doubled by such improvements in the environment as it is within our power to make. This is largely the province of the material sciences, but the reactions of the human machine are of immense importance. There are innumerable problems awaiting investigation and solution. Such are: the desirable hours of labor; the most efficient movements; interest, enthusiasm and imitation; all conditions favorable or unfavorable to work or other forms of activity, including ventilation, heating and lighting; food, alcohol, coffee and tobacco; rest, play and sleep; posture and strain in employments, conditions of fatigue and safety, wherever the central nervous system, the neuro-muscular mechanism and the senses are concerned.

I am less sanguine in regard to our power to alter the constitution of individuals, but we can at least safeguard psychology from false claims, and it may be that the child and even the adult may prove plastic under the right conditions. The savage could not imagine turning iron into steel, still less turning steel into a cantilever bridge. Schools, churches, the press, the family, customs, laws, governments, are indeed all means to control and direct behavior. Their success in altering individuals has been but modest, and it is by no means certain that psychology as a science can accomplish much more than the Book of Proverbs to improve the situation. Perhaps it can do something, especially in the way of the elimination of futile and harmful methods, and a generation of research by a thousand able men might contribute results of immense value, measured either economically or in terms of human welfare. At present, however, and perhaps always, we can do more to alter the environment and to place individuals in situations where their reactions are what we want than we can to alter individuals. Fortunately all men are not born equal; it is both undesirable and impossible to make them equal, or indeed to alter fundamentally the

constitution with which they are born. But we can give them equality of opportunity and more; for we can provide the best opportunity for each and improve the environment for all. Even though it may be difficult to alter people after they are born, it may ultimately be possible to select the kind of people that we want to be born.

"The harvest truly is plenteous, but the laborers are few." And this is in large measure because we limit ourselves to the solution of St. Matthew: "Pray ye therefore the Lord of the harvest, that he will send forth laborers into his harvest." We do not use tested business policies to organize our work, but wait for the lords of the harvest to find us and to care for us.

> The fault, dear Brutus, is not in our stars,
> But in ourselves, that we are underlings,

or, in modern terminology, it is not the situation, but our failure to apply scientific methods to our own work, that makes us a feeble group gathered in Chicago when we might be a dominant force throughout the world. We should be practical men and see to it that we have a practical psychology.

J. MCKEEN CATTELL

JOHN NELSON STOCKWELL

JOHN NELSON STOCKWELL, mathematician and astronomer, was born in Northampton, Massachusetts, April 10, 1832. When he was a little more than a year old his parents moved to Ohio, and at eight years of age he went to live with an uncle and aunt on a farm in Brecksville, not far from Cleveland. In speaking of his early education, he says he took very little interest in his studies until just before the outbreak of the Mexican War, when he became interested in history and, at the same time, began to solve arithmetical problems published in a weekly Philadelphia paper which found its way to Brecksville. It soon appeared that he could solve these problems readily and for a number of years he sent the answers to the paper week after week; he also worked every arithmetical problem he could find in old arithmetics which came into his hands. Algebra was not studied in the country schools in those days, and it was not until 1849 that he was able to begin work on this subject. He could find no teacher, but the subject proved to be so easy that he did not need one.

A total eclipse of the moon which occurred in November, 1844, first called his attention to celestial phenomena. From that time he was an ardent student of old almanacs and any other works which he could acquire dealing with astronomical events. When he was seventeen years of age, he secured a text-book on practical geometry and a year later began the study of general geometry, again without a teacher. So absorbed was he in mathematics that he found the work on the farm irksome and arranged to give less time to that and more to his studies. Olmsted's "Astronomy" and Dr. Thomas Dick's works gave him much practical information, but failed to satisfy him because they did not give enough theoretical work nor did they contain the mathematics necessary to predict astronomical events. The books he read frequently spoke of "La Place" and the "Mécanique Celeste." Young Stockwell, being determined to own this work, ordered it of a bookseller in Cleveland and received it in 1852, when he was twenty years of age. He found then, to his great surprise, that it consisted of four large quarto volumes and the cost was far in excess of anything he had imagined. But his desire for the work was so great that he was perfectly willing to give a half summer's work to get the money to pay for it. Before this time he had become somewhat familiar with calculus and was, therefore, able to understand much, if not all, of the content of these volumes.

From 1849 to 1851 he devoted all of his leisure to the study of geometry, trigonometry and higher mathematics, and in 1852 published a "Western Reserve Almanac of the Year of our Lord, 1853." By a mistake of the publishers his name was omitted from the title page and few, if any, knew the author. Soon after this he became acquainted with

Dr. B. A. Gould, who had recently begun the publication of the first astronomical journal in the country devoted to research work. In 1854, through the influence of Dr. Gould, Mr. Stockwell was appointed a computer in the Longitude Department of the United States Coast Survey and moved to Cambridge, Massachusetts, in order to carry on his work under Dr. Gould's direction.

Eight months later he returned to his uncle's home in Brecksville and resumed his farm work, giving all of his spare time, as before, to mathematics and astronomy. Before 1860 he had mastered the methods of computation of the orbits of planets and comets, and had computed the orbits of two comets which appeared in 1853. He computed the orbit, the perturbations and ephemeris of Virginia, the fiftieth asteroid, for its opposition in 1859. These results were published in the *Astronomical Journal*. In 1860 he published a new method of solving a set of symmetrical equations having indeterminate coefficients. In addition to these investigations, by 1860 he had begun a very extensive and elaborate computation of the secular variations of the planetary orbits arising from mutual attractions of each other. This work was interrupted by the war, however, and was not completed until 1872, when it was published in the Smithsonian Contributions to Knowledge. In 1861 he was given the position of computer in the United States Naval Observatory and continued in this work until 1864. At that time the United States Sanitary Commission, which had collected a large quantity of statistics in regard to sanitary conditions, requested Dr. Gould to reduce and discuss them, and he in turn asked Mr. Stockwell to assist him.

One day, while in Cleveland, he was inquiring in a bookstore in regard to the non-arrival from Europe of some books on the theory of probabilities. Shortly after that the book dealer mentioned this to Leonard Case, afterwards the founder of Case School of Applied Science, who said that he would loan these books to Mr. Stockwell as he happened to have them in his library. This act led to the acquaintance and friendship between these two men which continued for many years. Through the influence of Mr. Case, Mr. Stockwell soon afterwards moved to Cleveland and lived there during the remainder of his life. Mr. Case, a graduate of Yale University and a great lover of mathematics, persuaded Mr. Stockwell to undertake a complete discussion of the mathematical theory of the moon's motion. This work was never wholly finished but many specific problems in relation to the subject were completed and published from time to time.

During 1891 and later, Mr. Stockwell published a series of articles in various astronomical magazines on the subject of the ancient eclipses. If the theory of the moon's motion used in such computations is correct, then the predicted time of an eclipse will agree with the historical time, but if there are errors in the theory, the computed time will evidently differ from the historical time. Mr. Stockwell was able to prove that in a large number of cases the historical times agreed very closely with the theoretical times computed by his tables, and this proved that his theory of the moon's motion was substantially correct. Nearly a hundred ancient eclipses were computed and many of the results were published.

In 1881, after the death of Mr. Case, Case School of Applied Science was opened. It was but natural that the board of trustees should invite Dr. Stockwell (he had received the degree of doctor of philosophy from Western Reserve College in 1876) to become professor of mathematics and astronomy. He continued to serve in this capacity until 1887, but his tastes were for research and not for teaching and in the latter year he resigned his professorship and through the remainder of his life, devoted himself to that science which he had cultivated for so many years.

Among the many articles contributed by him to the journals, we find that a large proportion have to do with the theory of the moon's motion or the computation of eclipses based upon such theory. There are, however, many articles upon the orbits of comets,

chronology by means of ancient eclipses, inequalities in the motions of many of the planets, the procession of the equinoxes, and the mutual perturbations of planets.

In 1919 he published a new solution of the problem of the tides. In the preface to his work he says:

> The cause of the tides was sufficiently and correctly explained by Sir Isaac Newton in the year 1687; and the mathematical development of the effects produced by that cause upon the waters of the ocean has been the great unsolved problem before the scientific world for more than 230 years.

Mr. Stockwell believed that he had solved this problem, and in his recent pamphlet he gives two different solutions and a set of tables of the solar and lunar tidal waves, together with the method of computing the tides at any point on the earth's surface.

In 1855 he was married to Sarah Healy, a foster-daughter of his uncle, and they lived together for over sixty-one years until she died, at the age of eighty-three. Their life together was an ideal one. Besides taking upon herself much of the burden of domestic cares in order that her husband might devote himself more fully to his scientific work, she sympathized fully with him in all that he was doing and gave him her encouargement.

Dr. Stockwell continued his mathematical work up to within three weeks of his death. Although he lived to be eighty-eight years of age, his mind was perfectly clear, and until attacked by his last illness, he was able to carry on his work with much of the vigor which had always characterized his investigations. Occasional visits by him to my office kept me in touch with what he was doing, and I was very glad to be able to loan him, from the college library, some books which he did not possess. He was a natural mathematician and acquired his knowledge without a teacher because his clear, analytical mind was able to grasp and understand any mathematical or astronomical theory which intereted him. The long list of his published papers shows that he was also possessed of that rare type of mind—the type which can work out for itself new things in mathematics and science which clearly interpret the great laws of our universe.

CHARLES S. HOWE

SCIENTIFIC EVENTS

CHAIR OF LOGIC AT THE UNIVERSITY OF LONDON

DR. C. A. MERCIER, the distinguished London alienist, in his will offered $100,000 to London University to endow a chair under stipulations, sent us by Dr. E. E. Slosson. They are:

> Scheme for the establishment of a Professorial Chair of Rational Logic and Scientific Method. The purpose of this foundation is that students may be taught, not what Aristotle or any one else thought about reasoning, but how to think clearly and reason correctly; and to form opinions on rational grounds: the better to provide that the teaching shall be of this character, and shall not degenerate into the teaching of rigid formulæ and worn out supersitions, I make the following conditions:
>
> The professor is to be chosen for his ability to think and reason and to teach, and not for his acquaintance with books on logic, or with the opinions of logicians or philosophers. Acquaintance with the Greek and German tongues is not to be an actual disqualification for the professorship, but in case the merits of the candidates appear in other respects approximately equal, preference is to be given first to him who knows neither Greek nor German; next, to him who knows Greek but not German; next, to him who knows German but not Greek; and last of all, to a candidate who knows both Greek and German.
>
> The professor is not to devote more than one twelfth of his course of instruction to the logic of Aristotle and the schools, nor more than one twenty-fourth to the logic of Hegel and other Germans. He is to proceed upon the principle that the only way to acquire an art is by practising it under a competent instructor. Didactic inculcation is useless by itself. He is, therefore, to exercise his pupils in thinking, reasoning and scientific method as applied to other studies that the students are pursuing concurrently, and to other topics of living interest.
>
> Epistemology and the rational grounds of opinion are to be taught. The students are to be prac-

tised in the arts of defining, classifying and the detection of fallacies and inconsistencies.

The principle of causation is to be taught as a process occurring in nature, and applicable to material things, and not as a notion in the minds of philosophers.

Subject to these requirements, a wide discretion is to be allowed to the lecturer.

COURSE ON SCIENCE AS APPLIED TO INDUSTRY

The Sheffeld Scientific School at Yale University announces a new general course, to be given during sophomore and senior years on "Science as Applied to Industry" to be given next fall for the first time. The official pamphlet says:

The object of this course is to give students a broad training, based upon a knowledge of certain of the fundamental sciences and of scientific methods, for executive and managerial positions in the business world. The course is not designed for students seeking preparation for a professional career in some particular branch of science, such as chemistry, geology, or metallurgy, where problems of production are likely to occupy their attention.

In accordance with the theory of the freshman year, this course may be chosen by any member of the first-year class. The best approach, however, is said to be by Group II. of that year, comprising English, history, mathematics, chemistry or physics, and French, German or Spanish. The electives come only in junior and senior years; and the student will find his work closely laid out for him until then. The sophomore will take calculus, physics, his chosen modern language, a course in contemparary English, qualitative analysis, and mineralogy and crystallography.

In junior year the student will take physical chemistry, physical and historical geology, elementary metallurgy, drawing, industrial mineralogy, business finance, elementary economics, and more of the same sort of English. He may also elect from elementary botany, biology, or modern language, sufficient hours to fulfill the required number. When he becomes a senior, he will take general chemistry, economic geology, statistics and reports, industrial management, principles of accounting, elementary petrology and applied structural geology, metals and alloys, industrial management, and cost analysis. For electives, he may choose from elementary organic chemistry, industrial chemistry, economic and regional geology, business law, insurance, metallurgy of iron and steel, transportation and economic problems. The total of recitation, lecture, laboratory work and preparation comes to forty-six hours in sophomore year, forty-five and one half hours in junior year, and forty-five hours in senior year.

The pamphlet explains that "while no attempt is made to cover the entire field of natural and physical science as a foundation for the more practical business studies which form in the last two years an integral part of the course, attention is centered upon three branches of science, those of chemistry, geology, and metallurgy, the work in these sciences being so arranged that the natural and logical order of development is followed, covering in some cases four years of work in a single field. The scientific studies are supplemented in each of the years by general or cultural studies in English or modern language, and in junior and senior years by the study of economics, and of selected subjects within the general field of business administration."

STANDARDIZATION OF INDUSTRIAL LABORATORY APPARATUS

The Journal of Industrial and Engineering Chemistry states that through the efforts of certain apparatus manufacturers, there met informally at the Chemists' Club, New York City, representatives of the following companies to discuss the advisability of drawing up standard specifications for laboratory apparatus to be used in their industrial research and works control laboratories: Barrett Company, General Chemical Company, Atmospheric Nitrogen Corporation, Grasselli Chemical Company, National Aniline & Chemical Company, New Jersey Zinc Company, Solvay Process Company, Standard Oil Company of New Jersey, and E. I. du Pont de Nemours & Company.

Since most of these companies are members of the Manufacturing Chemists' Association of the United States, a committee composed of these members was appointed by the association to pass on the proposals of the informal committee and to recommend the adoption of the specifications resulting from the informal committee's work as standard for the members of the Manufacturing Chemists' Association.

Arrangements have been made for full cooperation with the committee on guaranteed reagents and standard apparatus of the American Chemical Society, and also with the committee on standards of the Association of Scientific Apparatus Makers. These specifications will be considered carefully by committees of these three societies, and it is expected that they will then be published as tentative for a period of 6 months in order to give time for general criticism. At the end of that time the specifications will be adopted as final. In carrying on this work an effort will be made to obtain specifications which will insure the cheapest mode of manufacture of a given instrument consistent with the duties that it must perform. The committee desires to cooperate fully with all industries, and any communications should be forwarded to the chairman, Dr. E. C. Lathrop, E. I. du Pont de Neumours & Co., Wilmington, Delaware.

SCIENTIFIC NOTES AND NEWS

HENRY ANDREWS BUMSTEAD, professor of physics at Yale University and director of the Sloane Physical Laboratory, on leave of absence this year to act as chairman of the National Research Council, died suddenly on the night of December 31, while returning from attendance on the scientific meetings at Chicago.

AT the Chicago meeting of the American Association for the Advancement of Science, vice-presidents of the association and chairmen of the sections were elected as follows: *Mathematics,* Oswald Veblen, Princeton University; *Physics,* G. W. Stewart, State University of Iowa; *Chemistry,* W. D. Harkins, University of Chicago; *Astronomy,* S. A. Mitchell, Leander McCormick Observatory, University of Virginia; *Geology and Geography,* Willet G. Miller, University of Toronto; *Zoological Sciences,* Charles A. Kofoid, University of California; *Botanical Sciences,* Mel T. Cook, Rutgers College; *Anthropology,* Albert Ernest Jenks, University of Minnesota; *Psychology,* E. A. Bott, University of Toronto; *Agriculture,* J. G. Lipman, Rutgers College; *Education,* Guy M. Whipple, University of Michigan.

PROFESSOR BRADLEY M. DAVIS, professor of botany at the University of Michigan, was elected president, and Professor H. E. Crampton, of Columbia University vice-president, at the Chicago meeting of the American Society of Naturalists.

THE American Society of Zoologists has elected as president Professor Charles A. Kofoid, of the University of California, and as vice-president Professor Aaron L. Treadwell, of Vassar College.

FIFTY-FOUR members attended the annual meeting of the American Society of Biological Chemists, Inc., held in Chicago from December 28 to 30. Officers elected for the year 1921 were: *President,* Donald D. Van Slyke; *Vice-president,* Philip A. Shaffer; *Secretary,* Victor C. Myers; *Treasurer,* Harold C. Bradley; *Additional Members of the Council,* Stanley R. Benedict, Otto Folin and Walter Jones.

DR. E. E. SLOSSON, associate editor of *The Independent* and formerly professor of chemistry in the University of Wyoming, has been elected editor of the Science Service, the temporary headquarters of which are at 1701 Massachusetts Avenue, Washington, D. C.

J. D. MACKENZIE has succeeded Charles Camsell, now deputy minister of mines, in charge of the British Columbia office of Geological Survey at Vancouver.

PROFESSOR SANARELLI, director of the Institute of Hygiene of the University of Rome, and editor of *Annali d'Igiene,* and Dr. Nicola Badaloni, a well-known writer on social medicine, have recently been made Roman senators.

Mr. Frank Bachmann has resigned his position as chief chemist, Industrial Waste Board, Connecticut State Department of Health, to accept a position in the sanitary engineering department of the Dorr Company of New York City.

R. S. Woglum, entomologist in charge of citrus fruit insect investigations in California for the Federal Bureau of Entomology, who for many years has been conducting researches in orchard fumigation with hydrocyanic acid, resigned on September 1 to head the newly established Bureau of Pest Control, in the California Fruit Growers Exchange, a cooperative organization of more than 10,000 citrus fruit growers.

Dr. John Lovett Morse, professor of pediatrics at the Harvard Medical School, who has been connected with the university since his graduation in 1887, has resigned, his resignation to take effect on July 1.

Professor A. B. Macallum, of McGill University, Montreal, will deliver a course of lectures, extending over seven months, at the medical college in Peking, China. He will leave for the Orient in March.

At the annual meeting of the Washington Academy of Sciences held on January 11, Dr. J. R. Johnston, chief of the Office of Plant Sanitation, Cuba, and director of research for the United Fruit Company, delivered the address on "Some problems in economic biology in tropical America." The 153d meeting of the academy will be a joint meeting with the Chemical Society of Washington and will be held in the Assembly Hall of the Cosmos Club (entrance on the south side of Cameron House) at 8:15 P.M., on Thursday, January 20, 1921. The retiring president of the academy, Dr. C. L. Alsberg, chief of the Bureau of Chemistry, U. S. Department of Agriculture will deliver an address on "The relation of chemical structure to physiological action."

The Cutter lectures on preventive medicine and hygiene were delivered at the Harvard Medical School on January 11 and 12, by Dr. Alonzo Taylor, on "General and specific effects of prolonged subnutrition."

Professor E. W. Skeats, of the University of Melbourne, Australia, made an address on January 4 before the Geological Conference at Harvard University on "The geology of the state of Victoria."

Professor John Merle Coulter, head of the department of botany at the University of Chicago, gave two lectures in Cleveland last month on the McBride Foundation of Western Reserve University. The subject of the lectures was "History and present status of organic evolution." The purpose of the Foundation is to offer to the citizens of Cleveland semi-popular lectures upon various subjects by representatives from other universities.

Services in memory of the late Major-General William C. Gorgas will be held in the hall of the Americas of the Pan-American Building, January 16, under the auspices of the Southern Society of Washington. The Secretary of War, Secretary of the Navy, Secretary of State, Adjt.-Gen. Peter C. Harris, Sir Auckland Geddes, and diplomatic representatives of Cuba, Panama and South American countries will deliver memorial addresses.

The *Journal* of the American Medical Association writes that at the suggestion of the Niederrheinische Gesellschaft für Natur- und Heilkunde, a memorial tablet is to be placed on the birthplace in Bonn of the Berlin physiologist N. Zuntz, who died last spring. To the pupils and friends of Zuntz the society has issued an appeal for contributions.

Dr. John Emory Clark, professor of mathematics in the Sheffield Scientific School of Yale University from 1873 to 1901, died on January 3, in his eighty-ninth year.

Regis Chauvenet, president emeritus of the Colorado School of Mines, chemist and metallurgist, died in Denver recently at the age of seventy-eight.

Elijah P. Harris, emeritus professor of chemistry at Amherst College, has died at Warsaw, N. Y., at the age of eighty-eight. Dr. Harris retired as professor of chemistry at Amherst in 1907.

DR. NATHAN SMITH DAVIS, of Chicago, formerly dean of the college of medicine, Northwestern University, died on December 22, at Pasadena, at the age of sixty-two years.

AT the annual meeting of the Carnegie Institution of Washington the Station for Experimental Evolution and the Eugenics Record Office at Cold Spring Harbor, without loss of their identity were, for administrative purposes, combined into the Department of Genetics, with C. B. Davenport, director of the department, Dr. C. C. Little assistant director for the Station, and Dr. H. H. Laughlin assistant director for the office. Professor Harold D. Fish, now of the University of Pittsburgh, was reappointed research associate of the department of genetics.

W. L. HARDING, governor of Iowa, in cooperation with Honorable J. B. Payne, Secretary of Interior, called a National Conference on Parks in Des Moines, Iowa, to be held January 10, 11 and 12. An unusually strong program was presented relative to national parks, state parks and municipal parks.

THE annual meeting of the Eastern Division of the American Philosophical Association was held at Columbia University, New York City, on December 28, 29 and 30. The address of the president, Professor R. B. Perry, of Harvard University, on "The appeal to reason," was given at the annual dinner on the evening of December 29.

THE fifth annual meeting of the American Association of Petroleum Geologists will be held at Tulsa, Oklahoma, March 17–19, 1921. Since the organization of the association, at Tulsa, in 1917, the membership has grown from less than a hundred members to almost six hundred. The meeting last year was held at Dallas, Texas. The present officers are: *President,* Wallace E. Pratt, Houston, Texas; *Vice-president,* Alex W. McCoy, Bartlesville, Oklahoma; *Secretary-Treasurer,* Charles E. Docker, Norman, Oklahoma; *Editor,* Raymond G. Moore, Lawrence, Kansas. Prominent geologists from all parts of the United States have signified their intention of attending the meeting, and business of vital importance will be transacted.

THE National Research Council has available for free distribution a few copies of its Bulletin No. 5, "The Quantum Theory," by Dr. E. P. Adams, Princeton. This bulletin is a digest of the large number of highly technical mathematical-physical papers which appeared shortly before and during the war period, many of which have not been readily accessible to American physicists and mathematicians. Copies of the bulletin have already been sent to all regular members of the American Physical Society and to a selected number of mathematicians and astronomers.

THE Rockefeller Foundation has given to France complete control over the elaborate antituberculosis organization established in the department of Eure-et-Loir at a cost of 4,000,000 francs. The organization consists of twenty-four dispensaries, four complete isolation services, a departmental sanatorium and laboratory. The system will serve as a model for similar organizations to be established by the government throughout the country. The Rockefeller Foundation is now assisting in the antituberculosis campaign in thirty-eight of the eighty-seven departments and it is expected that this work will be continued for two years more.

UNIVERSITY AND EDUCATIONAL NEWS

DARTMOUTH COLLEGE will receive a bequest of $250,000 under the will of Sanford H. Steele, to erect a memorial to his brother, Benjamin Hinman Steele, of the class of 1857, for instruction and research in chemistry.

THE Yale Corporation meeting on January 8 again postponed the election of a president to succeed Dr. Arthur T. Hadley.

TRUSTEES of the Connecticut Agricultural College have voted to ask the incoming State Legislature to appropriate $625,000, of which $400,000 is wanted to erect a new science building for the chemistry, botany, physics and bacteriological departments. Plans for

the building call for a three-story brick and limestone structure, 40 by 180 feet. In addition to this special appropriation, the legislature will be asked to increase the regular state biennial appropriation from $150,000 to about $225,000, to help meet increased costs.

Dr. Henry Cuthbert Bazett has been appointed professor of physiology in the Medical School of the University of Pennsylvania to succeed Dr. Henry T. Reichert, who retired last year. Dr. Bazett is the Cheselden Welsh lecturer of clinical physiology at Oxford, England, and has been connected with St. Thomas' Medical School.

Dr. S. A. Mahood, who has been in charge of investigations on wood cellulose and essential oils at the U. S. Forest Products Laboratory, Madison, Wis., for the past three years, has become associate professor in charge of organic chemistry at Tulane University.

Dr. Kenneth D. Blackfan, associate professor of pediatrics at the Johns Hopkins Medical School, has been appointed to the professorship of pediatrics at the Medical College of the University of Cincinnati.

DISCUSSION AND CORRESPONDENCE

LEUCOCHLORIDIUM IN AMERICA

Since I published the description of *Leucochloridium problematicum*,[1] Dr. H. A. Pilsbry has very kindly called by attention to three articles which deal with members of this genus. All of these are works on conchology and are merely incidental to descriptions of certain snails, yet they are interesting since they show that collectors of mussels were more or less familiar with the parasite before parasitologists had studied it in America.

The first article is that of Dall,[2] who writes:

> A singular sausage-shaped parasite, of which one end is attenuated into a slender tube, is found in *Succinea*. The soft parts of the snail thus affected are much distorted. The parasite is one phase of a Distome or fluke-worm, and is of a dark brown color and over an inch in length. It is known as *Leucochloridium americanum* Dall. An analogous species has been described from French Succineas, which is of a mottled green. This parasite attains its development in the intestines of thrushes which feed on Succinea, and may perhaps be fatal to these birds.

Bryant Walker[3] refers to a *Leucochloridium* species as follows:

> *S. ovalis* Gld. Abundant everywhere. This species is occasionally infested by a species of Leuchchloridium similar to the *L. paradoxum* Carus, found in the *S. putris L.* of Europe and figured by Baudon in *Jour. de Conch.*, V., 27, Pl. X., Fig. 6. In the same journal (V. 28, p. 205) is published a note from the late Thomas Bland, recording a similar occurrence in a specimen of *S. obliqua* Say.

Finally Hanham[4] states:

> *Succinea obliqua* Say (St. Charles River). . . . In cleaning some of these shells taken on November 8, 1891, a few of the finest living specimens contained peculiar parasite, reference to which is made by Dr. Dall in his useful pamphlet "Instructions for Collecting Mollusks, etc.," (*Leucochloridium*).

Since Dall gave the specimen a name some consideration of it is necessary. It is of course impossible to identify the worm since he did not describe it. The sporocyst was evidently more than one inch in length. The only other descriptive statement is that it "is of a dark brown color." If one is to construe this expression to mean that the sporocyst is solid brown, it is certainly not *Leucochloridium problematicum* Magath. From the text it seems to me one can not assume anything else.

It is interesting to note that all early references to the finding of the parasite in Amer-

[1] Magath, T. B., "*Leucochloridum problematicum* N. sp.," *Jour. Parasit.*, 1920, VI., 105–115.

[2] Dall, W. H., "Instructions for Collecting Mollusks and Other Useful Hints for the Conchologist," U. S. National Museum, Bull. 39, Part G, 1892, p. 10.

[3] Walker, B., "The Shell-bearing Mollusca of Michigan," *Nautilus*, 1892, VI., 18.

species as follows:

[4] Hanham, A. W., "Notes on the Land Shells of Quebec City and District," *Nautilus*, 1897, X., 102.

ica have been made by conchologists. This perhaps explains the lack of morphologic description of the parasite from America prior to 1920 since it was only of passing interest to snail collectors. It would be splendid if men who have the opportunity to collect certain groups of animals would save and turn over the parasites and symbiotic animals to those interested in these particular fields, and certainly we would work out life cycles much faster if this attitude were taken by professional collectors.

THOMAS BYRD MAGATH

MAYO CLINIC,
ROCHESTER, MINN.

SOME SIMPLE GENERATORS OF HIGH FREQUENCY OSCILLATIONS

TO THE EDITOR OF SCIENCE: In SCIENCE for October 15 is printed a letter from Mr. G. M. J. Mackay concerning the utility of helium as a convenient source for the production of high frequency oscillations. In this connection it may be of interest to call attention to some other simple forms of generators.

About fourteen years ago the writer was engaged to conduct some experiments for the late Professor Kristian Birkeland, of the Christiania University who, from observations made on his electric furnaces for the fixation of nitrogen, was led to believe that the arc, as therein used, was partly of an oscillatory nature. Birkeland's idea was to produce high frequency oscillations without the use of hydrogen, by simply keeping the arc in motion by means of a magnetic field, with a view to utilizing the oscillations for wireless telephony.

His idea also proved correct, as high frequency oscillations could easily be produced between two circular, water-cooled copper electrodes in a radial magnetic field. Telephonic messages were also transmitted by these means from the university buildings to Bygdoe, a distance of about two miles; but the hissing noises due to the arc made understanding very difficult.

In the device used, the electrodes were arranged horizontally, the upper electrode resting by its weight against the lower one. On switching on the current, the upper electrode was lifted a fixed distance by an electromagnet carrying the main current. This arrangement served to start the arc automatically whenever it went out, a thing that did not happen very often, however, when the apparatus and current were properly adjusted, the arc sometimes burning for hours without interruption. While the available voltage was 220, the voltage between the electrodes was comparatively low, to the best of my recollection about 50.

The energy of the oscillations was sufficient to permit a continuous spark of more than 1 cm. length to be drawn from the secondary circuit, easily melting the point of a thick iron wire. Moreover, it was found possible to increase this energy considerably by working up to three arcs in series on the above voltage. As a latter arrangement did not adversely affect the stability of the arc there seems to be no limit to the amount of energy that may thus be converted into a high frequency current.

An interesting phenomenon was discovered while working this type of a generator: While the oscillatory arc made the impression of a rotating cluster of fat, white sparks, producing a crackling sound, it would, when the current was properly reduced, completely change its character. The fat, white sparks would gradually disappear, giving way to a pale blue, almost noiseless arc, consuming only a fraction of the initial current. When this condition had been attained no current would flow through the primary oscillation circuit which could be detached without any effect on the arc. The latter was also fairly stable, but at a sufficient reduction of the current, or weakening of the magnetic field, it would go out with a sharp click. This arc strikingly resembled the glow obtained by discharges through moderately rarefied air.

In the course of the experiments, other surrounding media than air were tried, among them water. One day it was found that in using the latter medium it was not necessary

to subject the arc to the action of a magnetic field in order to produce oscillations. In fact, the oscillations obtained by simply immersing two copper rods in water and starting an arc between them were much more powerful than those produced by a single arc in air, and the stability of the wet arc left nothing to be desired.

This discovery so discouraged Professor Birkeland from pursuing his original line of investigations that the experiments were dropped.

Anders Bull

Chicago, Ill.,
October 25, 1920

ROMANCING IN SCIENCE

To the Editor of Science: "O tempus! O mores!" To one who has used Professor Cajori's book with some confidence, his reply[1] to Dr. Partridge is disturbing. Dr. Partridge concluded[2] that we do not know exactly what experiment Galileo performed from the leaning tower of Pisa. Professor Cajori in reply offers data that (apparently unintentionally) substantiate Dr. Partridge's statement, but he says that it appears to him *too sweeping*.

In Professor Cajori's "History of Physics" (p. 32) the following detailed account occurs:

> The first experiments, which Galileo made while he was a young professor at Pisa, were decidedly dramatic. At that time the doctrine that the rate at which a body falls depends upon its weight was generally accepted as true, merely on the authority of Aristotle. It was even held that the acceleration varies as the weight. Prior to Galileo it did not occur to any one actually to try the experiment. The young professor's tests went contrary to the doctrine held for two thousand years. Allowing for the resistance of the air, he found that all bodies fell at the same rate, and that the distance passed over varied as the square of the time. With all the enthusiasm, courage and imprudence of youth, the experimenter proclaimed that Aristotle, at that time believed by nearly every one to be verbally inspired, was wrong. Galileo met with opposition, but he decided to give his opponents ocular proof. It seems almost as if nature had resorted to an extraordinary freak to furnish Galileo at this critical moment in the history of science, with an unusual convenience for his public demonstration. Yonder tower of Pisa had bent over to facilitate experimentation, from its top, on falling bodies. One morning, before the assembled university, he ascended the leaning tower, and allowed a one pound shot and a one hundred pound shot to fall together. The multitude saw the balls start together, fall together and heard them strike the ground together. Some were convinced, others returned to their rooms, consulted Aristotle, and, distrusting the evidence of their senses, declared continued allegiance to his doctrine.

In his reply to Dr. Partridge, Professor Cajori gives "*the* historical data" and says that from them "it follows that Galileo dropped different weights of a variety of materials and noticed which of them fell faster."

Now, Mr. Editor, from what data does the above quoted thrilling account follow? And from what data and by what processes may other parts of history be reconstructed by scientists? And from what data must it follow in your readers' minds that Dr. Partridge is the scientist guilty of a "declaration" that is "too sweeping"? Recently it cost me many hours of painstaking experimentation to prove that certain improbable statements made in print by a scientist were directly contrary to fact; when the results of the investigation were sent to him, he replied that his had been *merely casual remarks!* Your correspondent happened to see the following in his Montaigne this morning, *Fortis imaginatio generat casum*—there translated, "A strong imagination begetteth chance."

David Wilbur Horn

Bryn Mawr, Pennsylvania

A THRICE TOLD TALE

The conversation which Professor Campbell describes, in a recent number of Science, as taking place at the eyepiece of the Lick telescope in September, 1912, prompts me to quote the closing paragraph of my article on the mercury telescope which appeared in the *Scientific American* for March 27, 1909.

[1] Science, October 29, 1920.

[2] Science, September 17, 1920.

I am tempted, in closing, to tell of the remark made to me by one of the older inhabitants of East Hampton who had paid my laboratory a visit. The milky way happened to be overhead and the mouth of the telescope pit was filled with hundreds of star images. "What are they all anyway?" he asked. "Suns like ours, only bigger," I replied. "You don't say so," he answered, "and have they earths and planets and things going round 'em, and are they all inhabited?" "Very likely," said I, "some people think so." He scratched his head and then turned to me with a restful smile and said, "Well, do you know, I dunno as it makes so *much* difference after all whether Taft or Bryan's elected."

The similarity between the two conversations leads me to believe that Professor Campbell's questioner was leading for an opening to repeat the remark of the old farmer.

Others have been similarly victimized, for in G. Lowes Dickinson's "Appearances" published in 1915, on page 163 a similar conversation occurs between the author and a lone telegraph operator in a railroad shack in the Rockies.

From one newspaper topic to another we passed to the talk about signalling to Mars. Signalling interested the youth; he knew all about that, but he knew nothing about Mars or the stars. These were now shining bright above us, and I told him what I knew of suns and planets, of double stars, of the moons of Jupiter, of nebulæ and the galaxy, and the infinity of space and of worlds. He chewed and meditated, and presently remarked, "Gee! I guess that it doesn't matter two cents after all who gets elected president."

Should it be discovered that the story appears also in the writings of Galileo, or Copernicus, or Pythagoras, it will mean that I too have been victimized.

R. W. WOOD

ARE THE LANCE AND FORT UNION FORMATIONS OF MESOZOIC TIME?

IN a paper recently published by Dr. Stanton we have for the first time a description of the complete fauna of the Cannonball member of the upper Lance formation, consisting of 73 forms; 2 are sharks' teeth, 6 are cup corals (described in an appended paper by T. W. Vaughan), 2 are foraminifers, and the rest are molluscs (31 bivalves, 1 scaphopod, and 31 gastropods). There are 41 new forms, and 2 remain unnamed specifically. Of the 71 invertebrates, but a single bivalve passes upward into the Fort Union freshwater beds (*Corbula mactriformis*), while 24 forms occur below in the marine Fox Hills or older Cretaceous formations. Not one of the species of the entire Cannonball fauna is known in the marine Eocene province of the Gulf of Mexico. In other words, "40 per cent. of the molluscan species in the Cannonball fauna are known in the combined Pierre and Fox Hills or Montana fauna of the same general region, and 30 per cent. of them have been found in the Fox Hills fauna. . . . The fauna clearly belongs to the open sea and was modified after Fox Hills time by the extinction" of the ammonoids and other forms, "and by the introduction of a considerable number of new types that are not known in the Fox Hills and Pierre faunas" (p. 12). This new element, however, is not distinctively Cenozoic, but consists of types that are elsewhere found in the Cretaceous.

Again, the Fox Hills fauna is about of the time of the *Exogyra costata* zone of the Atlantic and Gulf Coastal Plain. The last named fauna has, according to Stephenson, 168 molluscs, and yet not a single one passes upward into any Cenozoic formation. From these and other facts Stanton concludes that "a large element in the Cannonball fauna is directly descended without specific change or with only slight change from the preceding Cretaceous faunas of the Rocky Mountain and Great Plains region. These late Cretaceous faunas show a progressive modernization due to the gradual elimination of distinctive Mesozoic generic types and the concurrent introduction of modern generic types which continued through the Tertiary and are still living in the Recent fauna" (p. 12).

[1] "The Fauna of the Cannonball Marine Member of the Lance Formation," by T. W. Stanton, U. S. Geol. Survey, Prof. Paper 128-*A*, pp. 1–66, Pls. 1–10, 1920.

"It is my opinion that the fauna of the Cannonball marine member of the Lance formation indicates that the formation belongs within the hiatus discussed by Stephenson and below the line which he postulates as separating Cretaceous from Eocene. It is certainly somewhat younger than the zone of *Exogyra costata* and most probably considerably older than the Midway formation" (p. 15).

The regularly bedded marine Pierre strata pass unbroken into the irregularly bedded Fox Hills formation, this irregularity of bedding being due to tidal currents in the shallowing waters of a retreating sea. Above the Fox Hills, and without important break, lies the Lance, which is in the main of fresh-water beds ranging in thickness from 400 to 525 feet, and which has a Fort Union-like flora and ceratopsian dinosaurs. Then the marine waters return for the last time in the area of the Great Plains and deposit in the eastern part of the area of the Lance formation the Cannonball marine member, whose fresh-water equivalent is known as the Ludlow lignitic member, the two having each a maximum thickness of about 300 feet. To quote Stanton again:

> The Cannonball marine member rapidly thins toward the west until it is reduced to one or two thin beds which extend as tongues into the predominantly continental deposits of the Ludlow lignitic member (p. 9).

On the other hand, this lignitic member is difficult to distinguish from the overlying Fort Union. Hence we see that there is here a continuous and unbroken series of deposits from the Pierre and Fox Hills into the top of the Fort Union, and that the reported erosion contacts between the several formations are due to nothing more than changes from marine to brackish and fresh-water deposition, or to the irregularities characteristic of continental sediments, the local breaks not representing a loss of geologic time of any marked historical value.

Finally, Stanton presents two paleogeographic maps, one showing the position of the marine Lance with reference to the Pierre sea, and another to the Eocene seas. These maps are a most striking summation of the problem in hand, and at once bring out the fact that the Cannonball member is most closely related to the final Cretaceous seas, since there is no possibility of connecting these marine beds with those of the Eocene of the Gulf of Mexico area, or the Pacific Ocean.

Modern stratigraphers know well that it is more commonly the earlier and especially the middle formations of the periods that are preserved, and that the later parts are more or less absent. As a result of this, the systems of rocks are separated from one another by "breaks," representing intervals of time of varying length, when erosion was going on. No geologist can tell from the stratigraphy or the entombed faunas and floras how long these intervals lasted, but in favorable localities are often found sediments not only hundreds but thousands of feet in thickness which on the basis of their contained organic evidence can be shown to supply the record lost elsewhere in one of these breaks. Why is it that the later parts of the systems of strata are absent? In some cases this is due to lack of deposition, but, as above indicated, in most instances it is because of the inter-system erosion times. The strata last deposited are first to vanish under the influence of erosion, and their absence is almost general in stratigraphy for all the older periods of geologic time. In the more modern periods, however, we should expect the preserval of some of these latest strata of the rock systems, and the Lance with its marine Cannonball member and the overlying Fort Union appear to be the last deposits of the Cretaceous. They have long been known as the transition formations into the Eocene, but even so they do not fill the entire gap between the Pierre of the Cretaceous and the Wasatch of the Eocene. As LeConte says:

> But, as the change was gradual and the sedimentation continuous, of course the strata were in places conformable throughout. Thus, then, the Cretaceous was before, the Tertiary after, and the Laramie [in which he includes the Lance, Fort

Union, etc.] during, the Rocky Mountain revolution (''Elements of Geology'').

The reviewer therefore does not hesitate to state that to him the evidence relating to the field relations and stratigraphy, the orogeny and paleogeography, and the invertebrate and vertebrate fossils of the Montana series and the Fox Hills and Lance formations is now well enough in hand to conclude that all are unmistakably of Mesozoic time. Furthermore, as the Lance and Fort Union are continuous formations, have wholly archaic mammal faunas, and are broken by a period of orogeny and lack of deposition from the succeeding Eocene deposits with their wholly different and modernized mammal faunas, the line separating the Mesozoic from the Cenozoic apparently lies between the Fort Union and the Wasatch, and not between the Fox Hills and the Lance. From this conclusion the paleobotanists will of course dissent, but we have now come to the parting of the ways. Our floral brethren will continue to say that the Cenozoic begins with the Lance, but the dominating faunal evidence of the invertebrates and vertebrates, backed as it is by the field relations and the two movements of the Laramide revolution, binds invertebrate paleontologists and geologists together in the conviction that the Lance and the Fort Union are of Mesozoic time. The U. S. Geological Survey should now reverse its former conclusion and adapt itself to the fuller evidence.

CHARLES SCHUCHERT

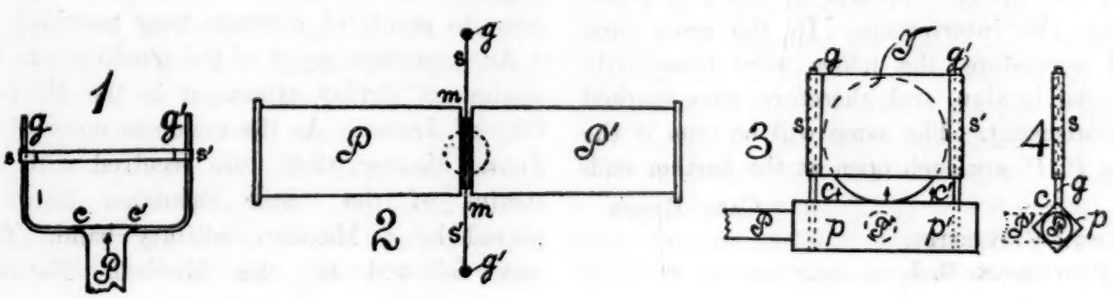
YALE UNIVERSITY

SPECIAL ARTICLES

AN ADJUSTABLE EMBOUCHUER

THE device shown in Fig. 1 was designed to evoke a definite note, fundamental or overtone, from cylindrical tubes, closed at one end or open at both. It consists of a brass tube P, pinched down at cc', so as to form a crevice 2 or 3 cm. long and not much more than $\frac{1}{2}$ mm. broad. From this issues a lamina of air striking the strip of thin brass ss' about 5 mm. broad. The strip ss' which is always to lie in plane of the lamina, is on guides gg' of thick copper wire, bent at right angles, as shown, and soldered to the ears of the crevice cc'. In proportion as a higher or lower note is to be evoked, ss' is placed nearer cc' or removed from it; for the nearer ss' is to cc' the higher the mean pitch of the siffling. For high overtones the adjustment is rather delicate and should be made (preferably) with a micrometer. In Fig. 1, ss' slides with slight friction and is moved by the fingers. In use, the apparatus is placed across the end of the pipe with the plane $gcc'g'$ normal to the axis. The particular note wanted is obtained by correctly setting ss', which operation sometimes requires patience. The best results are obtained with pipes of the one-foot octave, and of a diameter less than twice the width cc', pipes of about equal width with cc' being most satisfactory. From inch gas pipe, two feet long, a whole series of overtones may be evoked in succession. With a less exacting demand for an immediate response, clear notes may be obtained from a great variety of vessels. Thus bottles, deep tumblers and beakers, flat jars (like sardine boxes), truncated cones, thistle tubes and even thimbles respond, often very loudly.

Very disconcerting sounds are often obtained. Thus, for a wide-mouthed cylindrical jar, 3″ in diameter and 6″ high, tapering



down at the top to a mouth $1\frac{1}{2}''$ in diameter, the fundamental appears at once (*ss'* across the middle). If now the distance *sc* is decreased, the overtone will appear loudly. It is *not* the fifth above, however, but the *octave*, itself. As the kinematics of the stationary waves are given, the overtone belongs to an original wave of 3/2 longer wave-length than the fundamental.

Figure 3, 4, is another form of blower adapted for wide pipes, made of square brass tubing *pp'*. One edge of this has been filed down until a rift *cc'* may be cut with the fine blade of a knife. The strip *ss'* here advantageously covers the pipe *T* to be tested; or the hands may be used to cover projecting sides of *T*. The form, Fig. 3, with an alternative influx *P'*, may be duplicated, affording two opposed rifts and strips. Tin cups, funnels, etc., as well as long wide tubes respond to it sonorously.

Interference.—This experiment succeeded beautifully with the strip *ss'* of the blower, Fig. 1, placed between two coaxial pipes, *P* and *P'* (Fig. 2), each about 10 cm. long and 2 cm. in diameter (for instance) and closed at the outer end. Either pipe alone sounds vigorously when in position and actuated by the blower. With the two together there is a mere siffling, the wave running from end to end of the (virtually) double closed pipe *PP'*. Nevertheless, there is abundant room at *mm* for the escape of sound; indeed, one pipe, *P*, for instance, may even be placed at right angles to the other, leaving a wide open space, and still almost the whole compression of one pipe is alternatingly absorbed by the other. The experiment is an excellent illustration of the *reversal* of spectrum lines.

The nodes here are respectively dense and rare; *i.e.*, always opposite in the two pipes. Hence, the interference. In the cross pipe used heretofore, the nodes were necessarily identical in sign, and, therefore, gave marked reenforcement. The same will be true if the pipes *P*, *P'* are each open at the further end.

Carl Barus

Brown University,
Providence, R. I.

THE WESTERN DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The first Annual Meeting of the new Southwestern Division of the American Association for the Advancement of Science was held in El Paso, Texas, on Thursday, Friday and Saturday, December 2, 3 and 4, 1920. The officers at the meeting, elected at the Organization Meeting in April, 1920, were: President, Dr. Edgar L. Hewett, of Santa Fe; Vice-president and chairman of the Executive Committee, Dr. E. C. Prentiss, El Paso; Secretary-Treasurer, Dr. A. E. Douglass, Tucson. The Executive Committee included also Dr. John D. Clark, Albuquerque, Mr. A. L. Flagg, Phoenix, Professor Fabian Garcia, Mesilla Park, Mr. Arthur Notman, Bisbee, Mr. Robert S. Trumbull, El Paso, Professor Milton Updegraff, Prescott and Dr. Chas. T. Vorhies, Tucson. Dr. D. T. MacDougal was chairman of the organization committee. The affiliated societies participating in this meeting were, The American Association of Engineers, Southwestern District, The Medical and Surgical Association of the Southwest, The New Mexico Archæological Society. The Sante Fe Society of the Archæological Institute, The Mexico Medical Society and the El Paso County Medical Society. The trustees of Temple Mount Sinai loaned their very convenient rooms and auditorium for two days. The El Paso High School did the same for the final day and provided lunch. The Ad Club of El Paso entertained the members at lunch; the El Paso County Medical Society were hosts at a reception and dance at the Toltec Club. Excursions to points of interests were provided.

An important event of the meeting was the session on Friday afternoon in the Mexican City of Juarez. As the members entered the Juarez theater, they were received with the strains of the "Star Spangled Banner," played by a Mexican military band. This was followed by the Mexican National

Anthem. An address of welcome was given in English by Sr. Esquival, a response by Dr. Hewett, a welcome by the president of the Chamber of Commerce of Juarez, an address in Spanish by Sr. Ignacio Salas, special representative of the Mexican government, reading of papers, a response to the address of Sr. Salas, by Dr. D. T. MacDougal, closing with "America" given by the military band. The members visited the Agricultural College in Juarez, the old church and other points of interest.

The papers presented at the El Paso meeting occupied four sessions and were given in three sections, Human Science, Biological Science and Physical Science. The subjects specially dealt with were Psychology, Archæology, Education, Forestry, Ecology, Bacteriology, Astronomy, Geology, Chemistry and Medicine. Besides these a half day was devoted to a Symposium upon Southwestern problems. Dr. MacDougal of the Carnegie Institution spoke on Organization of Scientific Interests; Dr. Coan of the University of New Mexico, on Salient Historical Features; Dr. Shreve of the Desert Botanical Laboratory, Tucson, on Plant Distribution in the Mountains, Dean Working, of the University of Arizona, on support of Agricultural Research, Mr. Lawson of the U. S. Reclamation Service, on Reclamation Problems, Dean Butler, of the University of Arizona, on Mining Industry and Dr. Prentiss of El Paso, on Special Features of Medical work in the southwest. The presidential address by Dr. Edgar L. Hewett given Thursday evening in the auditorium of Temple Mount Sinai, was entitled "The Southwest—Yesterday and Tomorrow." It dealt with anthropological lines closely related to the subject of the Symposium. The chief address at the opening meeting on Thursday was by Dr. David Spence Hill, President of the University of New Mexico, on Basic Principles of Research.

In the final business session, a new Executive Committee was elected, consisting of Dr. Edgar L. Hewett, Santa Fe, Dr. John D. Clark, Albuquerque, Dr. V. M. Slipher, Flagstaff, Mr. A. L. Flagg, Phoenix and Professor Romulo Escobar, Juarez, Resolutions of thanks and of appreciation of Mexican cooperation were passed. In a meeting of the executive committee, Dr. A. E. Douglass of the University of Arizona, was elected president and Dr. E. C. Prentiss, of El Paso was elected vice-president and chairman of the executive committee. The secretary-treasurer for the year 1921 will be Mr. Howard W. Estill of the chemistry department of the University of Arizona.

THE AMERICAN CHEMICAL SOCIETY

(*Continued*)

The use of platinum crucibles in electro analysis. Copper determination: HAROLD VAN DOREN and JAMES R. WITHROW; and *The use of platinum crucibles in electro analysis. Rapid Copper determinations:* RUFUS D. REED and JAMES R. WITHROW. We have found that platinum crucibles can be used with proper precautions as readily as platinum dishes and more satisfactorily than flag electrodes for this purpose. Early workers in electro analysis naturally used platinum crucibles but the development of this application of chemistry brought in a variety of other forms, losing sight of the simpler form whose use is now made imperative for economical reasons. The application of the ideas of Richards and Bisby for crowding the current density in a small volume between two platinum crucibles within each other has been tried out and found with slight modification to be eminently satisfactory. Toluene has been found more satisfactory to prevent spraying than kerosene which can be used and which was suggested by Richards and Bisby.

Preparation of manganates and permanganates: H. MCCORMACK. This paper embodies a short description of the customary method for the production of sodium and potassium permanganate and indicates some of the complications in this process and the desirability of avoiding such difficulties by the modification of the process. The modification suggested consists in the crystallization of the sodium or potassium manganate, formed in the reaction between alkaline hydroxide and manganese dioxide, from alkaline solution. The permanganate is then formed by dissolving the manganate crystals in water and oxidizing by some suitable oxidizing agent. The method of oxidation recommended is electrolytic, using an

iron anode and cathode with an asbestos cloth diaphragm. A brief summary of results which have been obtained when operating on a commercial scale when using this method is given, and the advantages of operating in this manner as compared with the customary procedure are emphasized.

Estimation of benzene in admixture with paraffin hydro-carbons: H. McCormack. There is a considerable quantity of material being used to-day, particularly for motor fuels, which consists of a mixture of benzene and its homologues with gasoline. This has emphasized the desirability of securing a satisfactorily rapid and accurate method of estimating the quantity of benzene which may be present in such admixtures. Considerable study has been given this question by various observers and most of the properties of the compounds which may be present in such admixtures have been utilized from time to time in attempting such estimation. The methods which have heretofore been employed may be separated in two divisions. The methods of accuracy which are long and tedious, and methods of little accuracy which will be used in a short time. This paper describes a method by which the benzene is estimated from the quantity of bromine absorbed in the formation of di-brom benzene. Further work is in progress to determine the possibility of applying the method to estimation of commercial benzol in commercial gasoline where we will have present not only benzene and paraffin hydro-carbons, but also toluene, xylene, and other benzene derivatives.

The permanganate determination of sulfur dioxide: H. S. Coith and James R. Withrow; *The action of permanganate upon sulfur dioxide and sulfides:* F. C. Vilbrandt and Samuel L. Shenefield and James R. Withrow; and *The iodometric determination of sulfur dioxide:* Gordon D. Patterson and James R. Withrow. These three papers represent a study on various phases of the determination of sulfur dioxide from sulfuric acid plant and smelter fumes. The permanganate reaction with SO_2 proves to be the exception to the rule that permanganate goes to the MnO stage of oxidation in presence of sulfuric acid and sulfites going in part only to the MnO_2 stage, as is familiar in alkaline reactions. We have found in the case of the iodometric method which has proved satisfactory in the Marsden modification used by the Selby Smelter Commission that it can be applied also to high concentrations of sulfur dioxide if the color matching is not brought back to the original iodine color but the blank color brought down by thiosulfate to the end color of the SO_2 specimen.

Uniform packages for reagent chemicals: W. D. Collins. In order to secure better service in deliveries of reagent chemicals and to decrease the possibility of contamination in packing the following suggestions are made. (1) A set of standard sizes of packages for each reagent chemical should be adopted by the American Chemical Society. One fairly large and one small size would suffice for most reagents. Five hundred grams and either 100 or 25 grams would probably be selected. (2) Reagents should be sold by weight in grams. (3) Purchasers desiring reagents packed in other than standard packages should expect to pay proportionately more than for the standard packages.

Uniform specifications for chemical thermometers: R. M. Wilhelm.

Recovery of industrial gases with activated charcoal: O. L. Barnebey.

Evidences of auto-catalysis in the hydrogeration of cotton seed oil: O. R. Sweeney and Joseph Ellert. A series of experiments are given which were carried out to establish the best hydrogeration conditions using cobalt as the catalyzer. The shape of the curve (slope) indicated that auto catalysis was effecting the results. Experiments were made which seem to bear this out. Since this has never been observed, as far as we can learn, it would seem to be a matter of the utmost importance in view of the very considerable amount of research work being done along this line at present.

The use of ammonia oxidation to replace nitre in chamber plants: Charles L. Parsons. The large saving which is to be made by the use of ammonia oxidation instead of producing nitric acid in the ordinary way where the oxides of nitrogen are to be used in a gaseous form has already been pointed out by the author in the *Journal of Industrial and Engineering Chemistry,* Volume 11, page 451, 1919. On the recent trip to Europe a study was made of the practise in those countries, and it was found that ammonia oxidation was rapidly replacing any other source of oxides of nitrogen. In Germany this method was used almost exclusively, while in England some thirty plants have already adopted it, and no plant which has adopted it has changed back to niter. The plants which were visited and

some details of the operations in those plants were given.

A study of the separation of iron from aluminium by precipitation as Prussian Blue: G. O. BURR and HARRISON HALE. Precipitation of Prussian Blue from ferric salts with potassium ferrocyanide in the presence of aluminium was tried. Different concentrations of the salts and different strengths of free acid were used. It was found that the method was not applicable because of the formation of complex aluminium potassium ferrocyanides and the difficulty of filtering the Prussian Blue.

Fuel Symposium. A. C. Fieldner, *chairman*

Low temperature carbonization and its application to high oxygen coals: S. W. PARR. By low temperature carbonization is meant decomposition at a maximum temperature of 750°–800° C. This is not an arbitrary range but is a natural division below which substantially all condensible volatile products are discharged and the minimum amount of secondary decompositions occur. The main points of interest were fully summarized and described. In general, it is believed that all of the products of decomposition have a higher intrinsic value as delivered under low temperature conditions, chiefly because of the avoidance of excessive secondary decompositions. The solid residue is a smokeless fuel of from 5 to 15 per cent. volatile, free burning and of good texture, primarily adapted to use as a domestic or factory fuel. Whether suitable for metallurgical purposes or not has not been determined.

Carbonization of Canadian lignites: EDGAR STANSFIELD. This paper summarizes the results of an investigation on the carbonization of Canadian lignites carried out by the Mines Branch of the Department of Mines, and by the Lignite Utilization Board of Canada, at the Fuel Testing Station, of the Mines Branch, at Ottawa. The first series of experiments was carried out on 10 gram samples with exact temperature control, it showed the effect on the resulting carbonized material of widely differing conditions of carbonization: the results obtained have been used to control all larger scale work. The second series of experiments was carried out on samples of 1–3 kilograms. The experiments were similar to the above, but the tar, gas, ammonium sulphate, and water was also collected and studied. A weight balance sheet, thermal balance sheet and other results obtained in one set of experiments are given. The bearing of the above results, and of the economic conditions in southern Saskatchewan, on the design of a commercial carbonizer for that district are discussed, and the evolution from this laboratory investigation to the successful operation of a semi-commercial carbonizer of new design is traced. This carbonizer treated some 200 pounds of dried lignite per hour; the experience gained with it has been used to design a plant now being built by the board, near Bienfait, Saskatchewan, to treat 200 tons of raw lignite per day.

By-product coke. Anthracite and Pittsburgh coal as fuel for heating houses: HENRY KRIESINGER.

By-product coking: F. W. SPERR, JR., and E. H. BIRD. The paper discusses the present growth of by-product coke manufacture due to the increased use of its products as fuels. This growth is even, to a considerable extent, becoming independent of the iron and steel industry. The fuel efficiency of the by-product coke oven and the beehive oven are compared. The primary products of the by-product coke oven are discussed with relation to their use as fuel. There have been a number of new applications of these products that are important from this standpoint. The gaseous fuels manufactured from coke are also described, together with the possibilities for their future use in systems for the complete gasification of coal. The economical relation of the Koppers' combination oven fired with producer or blast furnace gas is noted, and other recent technical developments which have contributed to fuel economy are cited.

The charcoal method of gasoline recovery: G. A. BURRELL, G. G. OBERFELL and C. L. VORESS.

Colloidal fuels, their preparation and properties: S. E. SHEPPARD. Reasons for name, and history of development—colloid chemistry and fuels—suspensoids and emulsoids—viscosity conditions and stability requirements—stabilizing by protective colloids—development of plastic inner friction and "plasma" structure—peptization processes in theory and practise—accessory testing methods and practical trials.

Gasoline losses due to incomplete combustion in motor vehicles: A. C. FIELDNER, G. W. JONES and A. A. STRAUB.

Enrichment of artificial gas with natural gas: JAMES B. GARNER. The project of enriching artificial gas with natural gas is one which is of wide spread interest because of its possibility of providing a supply of a clean domestic fuel gas, uniform in quality and of sufficient volume to meet

the requirements of the public. This is particularly so in regions where natural gas has been used. Gas is more convenient, more economical and safer to use than any other fuel. There are in nature three potential sources of raw materials adequate for the production of a future domestic supply of manufactured gas. These three potential sources are bituminous shale, oil and coal. Artificial gas, as produced on a commercial scale, consists of the following varieties: Shale gas, oil gas, producer gas, water gas, carburetted water gas, coal and coke oven gas. The manufacture of a domestic supply of water gas, enriched with natural gas, serves two purposes—(1) It conserves in the highest possible manner our natural resources of coal, oil and gas and (2) it insures to the public an adequate supply at all times of a clean, uniform gas at the lowest possible cost. Natural gas companies should no longer be permitted to sell natural gas as such at ridiculously low rates but should be required to utilize it in the highest possible way, viz.: as a means of enriching artificial gas. Such use of this natural resource will insure to the public, for many years to come, a supply of gas at a cost otherwise impossible.

The commercial realization of low temperature carbonization: Dr. Harry A. Curtis. The carbocoal process for converting bituminous coal into a uniform, smokeless fuel resembling anthracite was developed by the International Coal Products Corporation at its experimental plant in Irvington, N. J. Both small apparatus and commercial size units have been in use there for the past four years, and there has been an opportunity to compare the results obtained in laboratory tests with those of plant operation. In the carbocoal process the crushed coal is carbonized first at a low temperature (900° F.), the resulting semi-coke is then ground and briquetted with pitch. The briquets are finally carbonized at somewhat below coke-oven temperature (1800° F.). The resulting fuel, carbocoal, is hard, dense, smokeless, and free-burning. More than a hundred coals, including a wide range of bituminous coals and lignites, have been tried in the process, and apparently any coal can be used successfully. Construction of the commercial plant at Clinchfield, Va., was begun during the war as a government war project. It was finally completed and put into operation in June, 1920. Its capacity is between five and six hundred tons of raw coal per day. (Lantern slides showing construction of commercial plant, yields of by-products, etc.)

Fuel conservation, present and future: Horace C. Porter.

Some factors affecting the sulfur content of coke and gas in the carbonization of coal: Alfred R. Powell.

The distribution of the forms of sulfur in the coal bed: H. F. Yancey and Thomas Fraser. A study has been made of the quantitative distribution of the forms of sulfur, namely pyritic and organic sulfur, in coal as it occurs in the various sections or benches of the seam. About 120 samples were collected at twenty working places in three mines, one operating in the number six seam in southern Illinois, one in the number nine and the other in the number twelve bed in western Kentucky. At each face the seam was divided into from four to eight benches and was represented by a corresponding number of samples. Some of the samples were taken at places in the bed which showed the coal intergrown and interbedded with lenses, bands, and cat-faces of pyrite. The purpose of the work was to determine if a relation exists between pyritic and organic sulfur, and in case segregations or concentrations of organic sulfur were found to exist, to associate such occurrences with other impurities or specific recognizable conditions. The data secured indicate no definite and absolute relationship between quantitative amounts of pyritic and organic sulfur in a given bed or sample. Samples taken at five faces in one mine indicate, in the majority of instances, that an increase in pyritic sulfur is accompanied by a decrease in organic sulfur. This is not uniformly true and the data do not warrant any such generalization, except to say that high pyritic sulfur and visible segregations of iron pyrite are not indicative of high organic sulfur content.

Charles L. Parsons,
Secretary

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